Influence of roads on small rodents population in fragmented forest areas, South Korea

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Abstract: The road effect on small rodent population is investigated at 8 fragmented forest areas in the Baekdudaegan mountain range, South Korea in September 2001. We especially focused on the distribution and body condition of small rodents near the roads. Korean field mouse (*Apodemus peninsulae*) seems to be more sensitive to the existence of a road than striped field mouse (*Apodemus agrarius*). Korean field mouse prefers interior forest area to around road. Striped field mouse is a habitat generalist and has wide distributional range around road, but Korean field mouse is forest-inhabiting species and their distribution is limited in forest area. These results suggest the effect of road is different on each small rodent species and their habitat preferences.

Keywords: Fragmented forest area; Road; Small rodents; South Korea
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Introduction

The construction and maintenance of roads were most widespread forms of modification of the natural landscape during the past century (Noss *et al.* 1994). Roads contributed to biodiversity loss, both directly via animal mortality related to traffic, and indirectly through the destruction and fragmentation of habitats. Their ecological effects are not only limited to the road region itself but can spread to a much large area (Meuiner *et al.* 1999).

As conducts for human vehicular traffic, roads represent major barriers to the movements of many organisms and a source of mortality across taxonomic groups, invertebrates and vertebrates (Rondinini *et al.* 2002). Road mortality is one factor, which is potentially important but has received little attention (Reed *et al.* 1996).

Road right-of-way areas attract many small mammal species (Adams *et al.* 1983) and offer nesting sites for birds (Laursen 1981; Warner 1992). However, beneficial effects may be limited to only generalist species. Their ecological importance for various species has received considerable attention in recent years (Angold 1997; Meunier *et al.* 1999).

The aim of this study is how road influences on the distribution and body condition of small rodents in fragmented forest areas. We hypothesized the existence of road and traffic volume would affect to the distribution and body condition of small rodent populations.

Methods

Study areas and sampling procedures

Three trapping plots were established at each of 8 fragmented forest areas in the Baekdudaegan mountain range, South Korea (Fig. 1). This mountain range involves high elevation mountains, diverse topographies and abundant species diversities in flora and fauna. For these reasons, three plots were chosen as similar forest structure to minimize differentiation of environmental factors except for a road effect in each 8 fragmented forest areas. Red pine (*Pinus densiflora*), larix (*Larix kaempferi*) and oak trees (*Quercus* spp.) were dominant tree species in study areas. Scattered patches of short woody vegetation are also present, including mountain berries (*Rubus cretaegifolius*), lespedeza (*Lespedeza* spp.) and deciduous tree seedlings, such as maple and ash trees.

The roadways in study areas included two-lane paved national road. Four trapping belts with width of 10 m and in length of 200 m were established in both sides of a road. Two trapping belts are located on ridge of road and the others are on 75 m away from road ridge. Each trapping belt involved 10 trapping stations.

Trapping stations within each belt were located 20 m apart. Snap traps baited with peanut were placed at the 'best' or 'most likely' spot for capturing small rodents, i.e. at base of tree, near logs, near tunnels, near rock, in runways through vegetation, within radius of station of 10 m.

All captured small rodents were identified, sexed and weighed. The reproduction stage was also recorded. Trap-

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ping was conducted during two consecutive days in September 2001, because this period is known as small rodent populations would be stable and most active in Korea (Rhim 1997; Rhim *et al.* 1998).

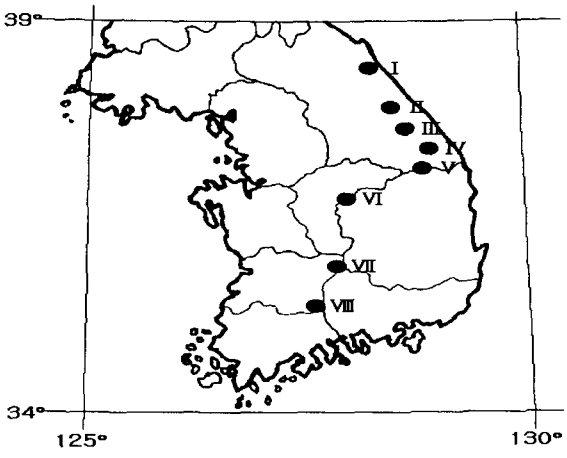

Fig. 1 The location of 8 study areas in South Korea

I----Jinburyeong; II----Jingogae; III----Sapdangryeong; IV----Baekbongryeong; V----Hwabangjae; VI: Ihwaryeong; VII----Deoksanjae; VIII----Yeowonjae.

Data analysis

We included two dominant species, Korean field mouse (*Apodemus peninsulae*) and striped field mouse (*Apodemus agrarius*) to analyze a road effect on small rodents, because of the small sample size of the other species, Yeowonjae was excluded from the analysis for the same reason. Seven study areas were finally included for analysis (Table 1).

The road effect on two dominant field mouse species was analyzed by using the number of individuals and mean body weight between two distance and traffic volume categories, respectively. The traffic volume is categorized into more and less 5000 vehicles per day. Body condition was simply calculated by mean body weight. The distribution was expressed by the number of captured individuals between two-distance categories.

Wilcoxon rank sum test was used to analyze the reaction of small mammal to distance from road or intensity of traffic volume. Data are presented as mean ± SD. In all tests, one-tailed probability is given unless stated otherwise. Alpha levels of 0.05 were considered to be statistically significant.

Results

Total 5 species of small rodents were captured in 8 study areas, especially (*Apodemus* spp.) were dominant in all areas. Saghalien pygmy shrew (*Sorex gracillimus*) was only captured in Hwabangjae area. Because identification of sex would be difficult and fewer information on the shrews, we could not identified the sex of captured. Korean large-toothed red backed vole (*Eothenomys regulus*) and brown rat (*Rattus norvegicus*) were captured only at Sapdangryeong and Yeowonjae areas, respectively. The most 23 individuals were captured in Sapdangryeong area and the least 5 individuals were at Yeowongjae area. The traffic volumes of 4 areas (Jinburyeong, Sapdangryeong, Hwabangjae, and Deoksanjae), were less 5000 vehicles per day. Jingogae, Paekbokryeong and Ihwaryeong are more 5000 vehicles per day (Table 1).

Table 1. Captured small rodents and traffic volumes in the 8 study areas in South Korea

Areas	Species	No. of total captured ind. (No. of juv. Ind.)	Sex ratio (M: F)	Mean body mass /g	Traffic volume (vehicles / day)
Jinburyeong	*Apodemus. agrarius*	5 (2)	1.5: 1	27.5	3170
	Apodemus peninsulae	6(2)	2: 1	30.6	
Jingogae	*Apodemus agrarius*	6 (3)	0.5: 1	33.5	5031
	Apodemus peninsulae	9 (2)	0.8: 1	35.9	
Sapdangryeong	*Apodemus agrarius*	14 (8)	1.8: 1	33.2	3934
	Apodemus peninsulae	7 (4)	1.3: 1	27.9	
	Eothenomys regulus	2 (0)	1: 1	36.2	
Baekbongryeong	*Apodemus agrarius*	3 (1)	3: 0	37.7	5181
	Apodemus peninsulae	13 (4)	2.3: 1	33.4	
Hwabangjae	*Apodemus agrarius*	2 (2)	2: 1	19.7	3033
	Apodemus peninsulae	13 (4)	0.6: 1	28.0	
	Sorex gracillimus	5 (0)	Unknown	5.6	
Ihwaryeong	*Apodemus agrarius*	3 (1)	2: 1	32.9	7331
	Apodemus peninsulae	8 (3)	3: 1	32.8	
Deoksanjae	*Apodemus agrarius*	19 (9)	1.7: 1	30.0	2304
Yeowonjae	*Apodemus agrarius*	2 (0)	0: 2	33.5	3820
	Apodemus peninsulae	1 (1)	1: 0	31.0	
	Rattus norvegicus	2 (0)	2: 0	70.0	

There was no difference in the number of captured individuals and mean body weight of striped field mouse between two distance categories (no. of individuals; Z=-0.79, P>0.2, mean body weight; Z=0.68, P>0.2), indicating roads do not affect on the distribution and body condition of striped field mouse. In the case of Korean field mouse, captured number of individuals between areas of 0 and 75 m from road was significantly different but mean body mass was not (no. of individuals; Z=-2.26, P<0.05, mean body weight; Z=0.43, P>0.3). Roads affect distribution but did not affect body condition in total of two field mouse species (no. of individuals; Z=-3.10, P=0.001, mean body weight; Z=0.77, P>0.2), (Fig. 2 and 3).

There was no difference in individual distribution between large and few traffic volumes (striped field mouse; Z=-0.54, P>0.5, Korean field mouse; Z=1.07, P>0.1). But body condition in few traffic volume areas is better than that in large traffic volume areas for Korean field mouse and total two species (Korean field mouse; Z=-1.75, P<0.05, total; Z=1.94, P<0.05) (Fig. 4 and 5).

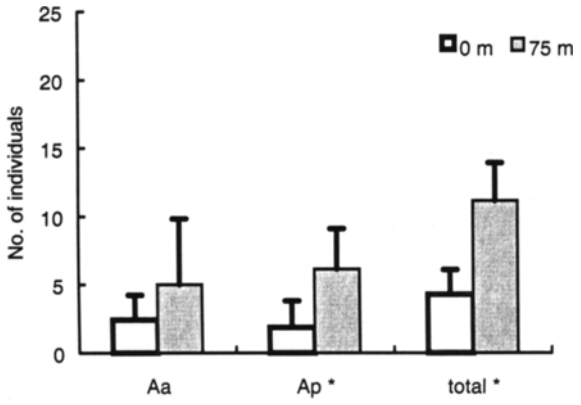

Fig. 2 Differences in the number of captured individuals (mean and SD) of two dominant small rodents species between areas of 0 and 75 m from road

Aa----*Apodemus agrarius*; Ap----*Apodemus peninsulae*

* ----denotes statistically significant (P < 0.05).

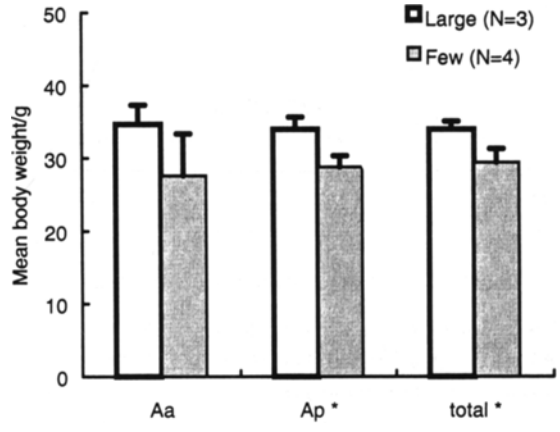

Fig. 3 Differences in mean body weight (mean and SD) of two dominant small rodents species between areas of 0 and 75 m from road

Aa----*Apodemus agrarius*; Ap----*Apodemus peninsulae*.

* ----denotes statistically significant (P < 0.05).

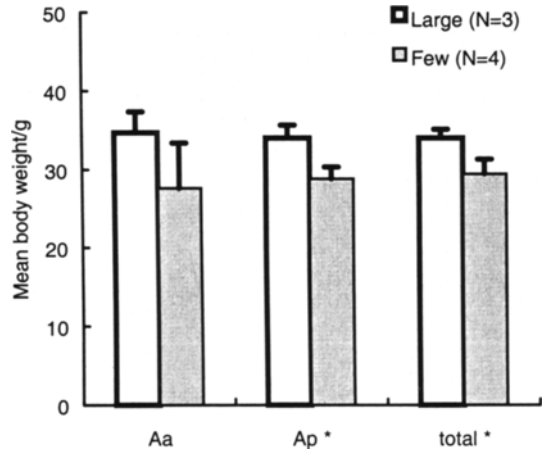

Fig. 4 Differences in the number of captured individuals (mean and SD) of two dominant small rodents species between large and few traffic volumes

Aa----*Apodemus agrarius*; Ap----*Apodemus peninsulae*.

* ----denotes statistically significant (P < 0.05).

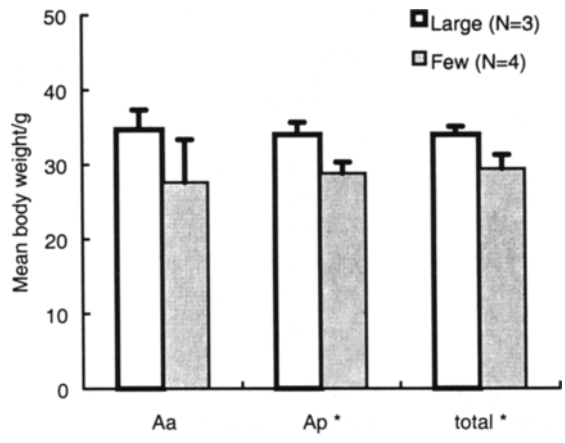

Fig. 5 Differences in mean body weight (mean and SD) of two dominant small rodents species between large and few traffic volumes

Aa----*Apodemus agrarius*, Ap----*Apodemus peninsulae*

* ----denotes statistically significant (P < 0.05)

Discussion

We tested a road effect on the distribution and body condition of small rodents. According to our results, Korean field mouse seems to be more sensitive to the existence of road than striped field mouse. Korean field mouse prefers interior forest area to around roads (Fig. 2). This situation is coincided with their ecology that striped filed mouse is a habitat generalist, but Korean field mouse is forest dwelling species distributing limitedly in forest area (Won 1967; Yoon 1992; Rhim *et al.* 2001a). Body conditions were not different between regions of 0 and 75 m from road in two species.

The distribution of the two species is not related to the intensity of traffic volume, but the body condition of Korean field mouse is (Fig. 4 and Fig. 5). The distribution may not be expected difference between two intensities of traffic volume because Korean field mouse originally distributes in the forest interior without relating to traffic volume. This may show that traffic volume may affect on the area within 75 m from a road.

In case of Korean large-toothed red backed vole, only 2 individuals were captured in regions of 75 m from road. This species is known as habitat specialist in forest of Korea (Rhim *et al.* 2001b). And then they would be so much sensitive to road construction.

Many authors reported that small rodents were more abundant on road verge (Adams *et al.* 1983, Bellamy *et al.* 2000). But those studied species were grassland specialist such as *Microtus,* which were not forest dwelling species. It seems that grassland specialist prefers the resources on the road verge, while forest specialist prefers the resources in the interior forest.

The road effect on small rodents may be different with the species and habitat preference. Although it is impossible to induce the causes from our results, all kinds of roads affect terrestrial ecosystem in several ways: (1) increased mortality from road construction, (2) modification of behavior, (3) alteration of the physical environment and (4) alteration of the chemical environmental (Forman *et al.* 2000). Further studies would be needed to clarify the road effect on small rodents' ecology, such as reproduction, behavior changes, etc.

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